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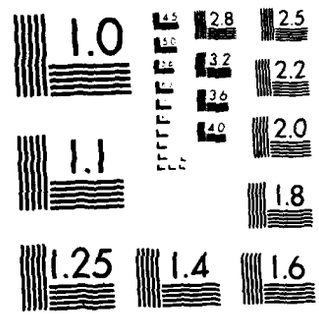

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-163074

MARCH 6, 1981

The Honorable Joseph P. Addabbo
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

Subject: The Army's Battery Computer System (MASAD-81-18)

Your September 4, 1980, letter asked us to evaluate test results of five Department of Defense weapon systems, including the Army's Battery Computer System (BCS). You asked us to determine whether the test results were valid and to ascertain whether congressional direction has been followed. We have previously reported to you our evaluation of test results involving four of the systems. Test data on the F/A-18 Fighter and the High Speed Anti-Radiation Missile has been discussed with subcommittee staff members and are presented in two of our annual reports to the Congress on major weapon systems: "F/A-18 Naval Strike Fighter: Progress Has Been Made But Problems and Concerns Continue" (MASAD-81-3, Feb. 18, 1981) and "Review of the High Speed Anti-Radiation Missile Program" (C-MASAD-81-7, Feb. 28, 1981). Testing issues on the Army's PATRIOT missile and the Navy's CAPTOR mine system were also discussed with subcommittee staff members.

This report describes our evaluation of the BCS test results.

DESCRIPTION OF BCS

BCS is designed to give artillery batteries an improved computational capability when integrated with the Tactical Fire Direction System (TACFIRE). This capability is needed to reduce mission response time and improve weapon effectiveness. BCS will replace the Field Artillery Digital Automatic Computer and the TACFIRE Battery Display Unit, which provides the batteries with firing data. BCS's introduction into

(951583)

TACFIRE could satisfy a longstanding requirement for battery-autonomous operations.

The Army awarded a 5-year, multiyear production contract to Norden Systems Incorporated in April 1980 for 687 systems for the Active and Reserve Forces. The contract price is $97 million; however, with contractual provisions for inflation, the total actual contract cost could be about $131 million. If the entire authorized Army objective of 1,200 systems is procured, the project manager estimates that the total procurement cost could be over $274 million.

RECENT TESTS WERE NOT OPERATIONAL TESTS

The initial operational tests conducted on BCS in 1979 had very negative results. They showed that BCS did not meet many of the operational requirements, such as accuracy, interoperability, reliability, and maintainability, and did not provide an improved capability over existing equipment.

The recent tests of BCS, conducted by the Army at Ft. Sill, Oklahoma, were limited to tests of software and built-in test equipment. They demonstrated that many of the software and built-in test equipment deficiencies have been or can be corrected. (See enc. I.) However, these tests were the laboratory type, which are models or representations of reality, and do not demonstrate operational effectiveness and suitability nor the reliability of BCS. We are concerned that the operational-type tests that can demonstrate the operational effectiveness and suitability of the system are not presently scheduled to be conducted until February and March 1982. This is just prior to the scheduled April 1982 third-year production continuation decision. This decision involves the production of 217 systems at a cost of about $47 million. It does not appear that, even if all goes as planned, there will be adequate time to evaluate the operational test results before the April 1982 production decision. Therefore, the Army may make this next production decision regardless of the test results.

The importance of operational tests cannot be stressed enough. These tests are conducted with typical user operators, crews, and units in as realistic an operational environment as possible. Their purpose is to provide data to determine the military utility, operational effectiveness, and operational suitability of a new system.

CONGRESSIONAL DIRECTION NOT FOLLOWED

The House of Representatives' report on the fiscal year 1981 Department of Defense Appropriations Act (H.R. 96-1317) directed that, before obligation of the fiscal year 1981 appropriation for BCS, the Secretary of Defense must certify that deficiencies identified in the 1979 development/operational tests have been corrected and successfully tested and that the test results demonstrate that the system meets all contract specifications for performance and reliability.

The Secretary of Defense has been unable to certify that the deficiencies identified in the 1979 tests have been corrected. However, he has authorized the Army to proceed with the obligation of the fiscal year 1981 appropriation for BCS. (See enc. II.) This second-year production buy, awarded by the Army on January 16, 1981, will cost about $35 million. In his December 20, 1980, letter to you, the Secretary stated that additional testing, including the 1982 operational tests, will be conducted before BCS is authorized for deployment. The Army currently plans to deploy BCS in late 1982.

CONCLUSION

We believe that although the recent laboratory tests demonstrate improvements in system software performance, there has not been sufficient testing to date which produces evidence from which an estimate of the operational effectiveness and suitability of BCS can be derived.

RECOMMENDATION

We recommend that the Secretary of Defense delay the third-year production continuation decision to provide sufficient time to evaluate the 1982 tests results and allow time for any retesting that may be necessary. There should be no further production approval if the operational tests do not justify producing more units.

SCOPE AND METHODOLOGY

During our review, we visited Ft. Sill, Oklahoma, where we observed the laboratory tests being conducted and attended briefings regarding the test results. We considered the tests and the way they were conducted to be adequate for what they were, laboratory-type tests. At the program office located at Ft. Monmouth, New Jersey, we attended the special In-Process Review during November 1980. Our review also included a visit to the contractor's facilities at Norwalk,

Connecticut. At each location we discussed the program with agency and contractor personnel and obtained program documentation. We received exceptional cooperation from the Army and the contractor during this review.

We did not evaluate the effect of major computer hardware and software standardization efforts in the Department of Defense on BCS. One of these efforts concerns the use of a standard language for military computers--Ada. We reported on this issue on June 18, 1980, in our report "The Department of Defense's Standardization Program For Military Computers--A More Unified Effort is Needed" (LCD-80-69). Ada is not included in the BCS or TACFIRE development and production programs, even though it will be the primary Department of Defense computer language.

As arranged with your office, we did not obtain official agency comments on this report and we plan no further distribution of this report until 5 days from the date of the report, unless you publicly announce its contents earlier. Then, we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

Milton J. Socolar

Acting Comptroller General
of the United States

Enclosures - 2

THE ARMY'S BATTERY COMPUTER SYSTEM

The Army has long recognized a need to provide an automated computational capability at the battery level within the artillery forces to meet the battlefield threat. As the battlefield tempo increases, the Army contends it must have more rapid and accurate delivery of field artillery fire against enemy targets and increased battery survivability. According to the Army, the Battery Computer System (BCS), will

--increase mission effectiveness by reducing mission response time,

--improve weapon effectiveness by allowing for more flexibility in battery positioning, and

--achieve independent or autonomous battery level operations when required.

In this regard, BCS is intended to replace the older Field Artillery Digital Automatic Computer and the Battery Display Unit within the Tactical Fire Direction System (TACFIRE). As a computer replacement, BCS is intended to satisfy the computational capability requirement for weapons control in units not equipped with TACFIRE. As a display unit replacement, BCS should satisfy the field artillery requirements for independent battery operations and independent weapon technical fire direction computations and provide a capability for forward observers to communicate directly to the battery when required.

BCS consists of a battery computer unit, a display unit for each gun, internal power, and all necessary mounts and cables to interface with communications and other Government-furnished equipment.

HISTORY OF BCS

TACFIRE is a computer-based system which automates selected field artillery command and control functions such as fire control and fire planning. TACFIRE transmits gun commands from the Battalion Fire Direction Center to a Battery Display Unit. This approach requires that all forward observer communications be made to the center and subsequently to the batteries. This imposes operational restrictions on the system with respect to deployability, survivability, and use of forward observers to provide a quick response and to direct fire control missions.

ENCLOSURE I

Battalion artillery tests have been conducted since 1969 to determine the sources of errors associated with field artillery fire direction procedures and to investigate alternatives to reduce those errors. Various configurations of targets, forward observers, fire direction centers, and artillery batteries have been employed throughout the tests.

Tests conducted from May 25, 1975, to June 11, 1975, combined developer and user field experiments to conduct field experiments using an automated fire control system integrated with new operational techniques. The tests were conducted to validate the need for certain BCS requirements.

The BCS required operational capability, incorporating the May to June 1975 test results, was approved in October 1975. At that time the Army decided to allow BCS to proceed directly into engineering development using available technology and devices.

In February 1976 a Request for Proposal was issued to approximately 50 firms. In late September 1976 an engineering development contract was awarded to Norden Systems Incorporated of Norwalk, Connecticut. By January 1979 Norden had delivered 10 engineering development models. The cost of this development effort was about $11 million.

Throughout the development program, the House Armed Services Committee expressed concern over the amount of research and development funds being expended on the BCS program. The Army subsequently established a ceiling for funding the remainder of the engineering development program in late 1978. This action led directly to a stopping of contractor effort on March 31, 1979. While the bulk of hardware tests had been completed, over 500 software problems--detected during the development and operational test phases of the program--had been identified but left uncorrected due to the Army's self-imposed funding constraints.

In August 1979 the Army conducted a review of the BCS program. At this review a decision was made to enter production using a 5-year, multiyear contract. During the review it was stipulated that nine major areas in which BCS did not comply with contract specifications required correction. These deficiencies were to be corrected as follows:

--Two of the areas, software and the built-in test equipment, were to be corrected and tested during a preliminary production test within 6 months after contract award. A special In-Process Review was to be held

before award of the second-year production for 168 units to insure that the deficiencies had been corrected.

--Six of the problem areas are planned to be corrected in the production models and tested during first article test and the follow-on evaluation in late 1981 and early 1982, respectively.

--The remaining problem involving a need to mount the system in a jeep for use in the Artic was eliminated when the user determined the requirement for jeep mounting was no longer valid.

On April 21, 1980, Norden was awarded a $97 million, 5-year, multiyear contract for 687 systems; however, with contractural provisions for inflation, the total actual contract cost could be about $131 million. The initial increment of 89 systems was approved at that time and the Government was obligated to approve the second increment for 168 systems no later than November 30, 1980. This was subsequently extended to January 16, 1981. On December 20, 1980, the Secretary of Defense authorized the continuation of the program. The second-year production was awarded by the Army on January 16, 1981.

Recent BCS laboratory-type test results

As stipulated during the August 1979 In-Process Review, the Army conducted additional laboratory-type testing subsequent to the award of the production contract. These laboratory-type tests were completed during September and October 1980 at Ft. Sill, Oklahoma. Their purpose was to retest the software and built-in test equipment deficiencies which were corrected by the contractor. These types of tests are models or representations of reality and do not demonstrate operational effectiveness, suitability, or the reliability of BCS.

BCS software test results

Each BCS has a magnetic tape in a sealed cartridge which contains the operating program, application programs, and data base to perform the battery artillery mission. This is the BCS software.

Numerous scenarios were devised to test the many functions the system can perform. The BCS software tests specified how a particular function should perform and/or the correct answer if a computation was required.

ENCLOSURE I

During the 1979 tests, over 500 software deficiencies were reported. The following chart summarizes these deficiencies by functional area and the disposition of them at the conclusion of the recent tests.

BCS Software Test Results

	1979 test deficiencies	Recent test results					
		Closed (note a)	Fixed	Not fixed (note b)	Not duplicated (note c)	Deferred (note d)	New problems (note b)
Accuracy	32	1	29	0	0	2	0
Ammunition & fire unit status	106	20	69	1	0	16	3
Interface	112	30	61	1	16	4	0
Lockups	28	0	9	0	19	0	3
Command and control	123	14	94	0	10	5	4
Data base	25	3	12	0	3	7	1
Format & parameter checking	89	17	55	1	10	6	3
Miscellaneous	22	2	10	0	1	9	1
Total	537	87	339	3	59	49	15

a/Previously corrected and tested or insignificant.

b/According to the contractor, these problems have been corrected subsequent to the recent tests.

c/Recent tests procedures unable to cause problem to occur.

d/Correction of problem deferred to later version of program tape.

Built-in test equipment test results

Each BCS also contains built-in test equipment. The purpose of this equipment is to alert the operator that BCS is malfunctioning and to identify which circuit board or component needs replacing, this latter function being the more critical of the two.

During the testing of this equipment, physical damage to the hardware (i.e., a circuit board or other major component) is caused intentionally to determine whether the equipment can (1) detect that a failure has occurred and (2) identify the location of the failure.

Out of 170 instances during the 1979 tests, the built-in test equipment detected the failure 162 times and identified the defective component in 130 cases. This was below the contract specification of 90-percent identification.

During the recent tests of the 40 failures that were retested, the equipment detected all 40 failures and identified the defective component in 25 cases. Also, the 130 successful cases of the 1979 test were retested along with 5 new cases. The equipment detected and identified the failed component in all of the cases. Based on these tests, the equipment now meets contract specifications, which requires that 90 percent of the defective components be identified.

The equipment tests results are summarized below.

Built-In Test Equipment
Testing Summary

	Failures inserted	Failures detected	Defective component identified	Percentage identified
Original test	170	162	130	76.5
Retest	a/175	175	160	91.4

a/Added five new failures.

ENCLOSURE II

THE SECRETARY OF DEFENSE

WASHINGTON D C 20301

DEC 20 1980

Honorable Joseph P. Addabbo
Chairman
Subcommittee on Defense
Committee on Appropriations
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

This letter concerns the House of Representatives Report on the Department of Defense Appropriation Act, 1981, H.R. Report No. 96-1317, regarding the Army Battery Computer System (BCS).

The Army has just completed a BCS program review, and has recommended that the program proceed into the second year of production. The successful completion of the required testing demonstrated that the software and built-in test equipment deficiencies can be corrected, and justified the concurrent production/correction decision. (The Army's management plan was modified to include testing of the production models by the Operational Test and Evaluation Agency, and the Army will review those test results before BCS deployment is authorized.) All testing will be repeated periodically to insure continued specification compliance.

In response to Congressional concerns, the Army has recently taken action to install and test the engineering changes designed to improve reliability on an engineering development model, to gain early assurance of the effectiveness of these corrections. The scope of the built-in test equipment retest will also be expanded.

Although the BCS has not demonstrated in testing that all specifications for performance and reliability have been met, the Army has substantially corrected and tested the software and built-in test equipment deficiencies, and identified the remaining hardware corrections. I conclude, therefore, that the BCS program is proceeding satisfactorily, and that production is now appropriate. I have authorized the Army to proceed with the second year of production.

I hope that this addresses the Committee's concerns.

Sincerely,

Harold Brown

Attachment

BCS Program Review

At a management review immediately following Development/ Operational Test II (DT/OT II) last year, the Army determined that the hardware, with minor changes, was ready for production, and that two deficient areas, software and built-in test equipment, had to be corrected and retested prior to authorization of the second year procurement.

That testing has now been completed. Of the 537 software deficiencies found in DT/OT II, 87 were subsequently found to be duplications of other problems or were not deficiencies. The correction of 49 deficiencies was deferred by the U.S. Army Training and Doctrine Command because planned changes to the production model hardware and software would result in additional changes to these areas. The remaining 401 deficiencies were required to be fixed by the contractor.

As a result of testing the contractor corrections to those deficiencies, only three technically minor problems remain, and they will be fixed in the next software version.

The built-in test equipment test included a retest of all faults that were not correctly detected or isolated in DT/OT II, plus a sampling of correctly detected and isolated faults from DT/OT II, and five new faults. As a result of the combined test results from DT/OT II and the retest, the built-in test equipment now meets specifications when tested in a laboratory environment. It will be tested further in an operational environment during the Follow-On Evaluation.

The engineering changes required to correct the remaining noncompliant areas, including reliability, have been identified and will be installed on the production models. Due to the nature of the changes, additional government testing before the production models are available was deemed not necessary. Specifically concerning reliability, analysis of the DT/OT II test data revealed two recurring hardware failures. The components that failed are either being designed out of the production models or are being replaced by more reliable components. As a result, reliability of the production models is projected to exceed the minimum acceptable value. All corrections to the system will be tested on the production models during the First Article Tests and Follow-on Evaluation scheduled in fiscal year 1982.

The Army has negotiated a multiyear firm fixed price contract which fixes the average unit cost below the design to cost ceiling.

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